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| EXAMINER |
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TSAL, H JEY

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| ART UNIT | PAPER NUMBER |
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2812

DATE MAILED: 10/28/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/615,362

Applicant(s)

PARK ET AL.

Examiner

H.Jey Tsai

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 06 August 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 14-26 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 14-26 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 08 July 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 23-26 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The description of "unitary" plug is not disclosed in the specification.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. § 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 14-15, 17, 19, 20, 21 and 23-24 are rejected under 35 U.S.C. § 102(b) as being anticipated by Blair et al. 5,998,873, newly cited.

Blair et al. discloses a method of forming a metal contact in a semiconductor device, which includes:

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forming an insulating layer 316 having a contact hole 318 therein on a silicon substrate 300, fig. 6+ and col. 5, lines 15+,

forming a PVD cobalt layer 324 on a bottom and inner walls of the contact hole 318, fig. 2 and col. 5, lines 35+,

forming a cobalt silicide layer 36 at the bottom of the contact hole 28 while forming a CVD titanium nitride (TiN) layer 326 directly on the cobalt layer 324, the metal silicide interface layer reaction conditions, such as temperature and gaseous ambient are selected, col. 5, lines 50-67 and fig. 8,

forming a unitary plug 330 on the titanium nitride layer 38 so as to fill the contact hole, figs. 9-11,

titanium nitride (refractory nitride) is used to assist in filling the contact, hence, titanium nitride is a part of unitary plug 44,

titanium nitride thickness is 100-400 angstroms, col. 5, lines 50+,

cobalt thickness is 75-300 angstroms, col. 5, lines 45+.

Claim 23 is rejected under 35 U.S.C. § 102(b) as being anticipated by Sumi 5,700,722, newly cited.

Sumi discloses a method of forming a metal contact in a semiconductor device, which includes:

forming an insulating layer SiO₂ having a contact hole therein on a silicon substrate Si, fig. e and col. 4, lines 48+,

forming a cobalt layer on a bottom and inner walls of the contact hole,

forming a cobalt silicide layer (Co silicide) at the bottom of the contact hole while forming (filling the contact hole) a unitary plug on the cobalt layer.

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Claims 14, 17, 19, 20, 23-24 are rejected under 35 U.S.C. § 102(b) as being anticipated by Wieczorek et al. 6,271,122.

Wieczorek et al. discloses a method of forming a metal contact in a semiconductor device, which includes:

forming an insulating layer 119 having a contact hole 102 therein on a silicon substrate, fig. 2A+ and col. 4, lines 56+,

forming a PVD cobalt layer 115 on a bottom and inner walls of the contact hole 102, fig. 2B and col. 5, lines 25+,

forming a cobalt silicide layer 109 at the bottom of the contact hole 102 while forming a titanium nitride layer 115 directly on the cobalt layer 115, col. 5, lines 32+ and fig. 2C,

forming a unitary plug 117/115/109 on the titanium nitride layer 115 so as to fill the contact hole, fig. 2D,

titanium nitride (refractory nitride) is used to assist in filling the contact, hence, titanium nitride is a part of plug 117,

titanium nitride thickness is 100 angstroms col. 5, lines 23+,

cobalt layer is 80-100 angstroms.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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Claims 16, 21 and 25 are rejected under 35 U.S.C 103 as being unpatentable over Blair et al. as applied to claims 14-15, 17, 19, 20 and 23-24 above, and further in view of Kamoshima et al. 2002/0093097 and Zhao et al. 6,297,555, both are previously cited.

The difference between the references applied above and the instant claim(s) is: Blair et al. teaches forming cobalt silicide while forming titanium nitride but does not teach the specific range of coating thickness and temperature. However, Kamoshima teaches at para. 53 and 57, forming a CVD TiN on the cobalt (Co) film at about 500° C to form a cobalt silicide and Zhao et al teaches at col. 5, lines 25-33, forming titanium nitride at about 340-500 degree C with thickness about 20-200 Angstroms and the specific coating thickness and temperature of cobalt and titanium layers as claimed are taken to be obvious since these are variables of art recognized importance which are subject to routine experimentation and optimization and discovery of an optimum value for a known process is obvious. In re Aller, 105 USPQ 233 (CCPA 1955). And, even if applicants' modification results in great improvement and utility over the prior art, it may still not be patentable if the modification was within the capabilities of one skilled in the art, In Re Sola 25 USPQ 433.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the above references' teachings with specific coating thickness and temperature of titanium nitride and cobalt as taught by Kamoshima et al. and Zhao et al. because forming titanium nitride at higher temperature such as 400-500 degree C would cause cobalt layer to form a cobalt silicide in the bottom of contact hole

and the thickness can be adjusted to obtain an optimum resistance for the cobalt silicide.

Claims 18, 22 and 26 are rejected under 35 U.S.C 103 as being unpatentable over Blair et al. as applied to claims 14-15, 17, 19, 20 and 23-24 above, and further in view of Givens et al. 6,091,148, previously cited.

The difference between the references applied above and the instant claim(s) is: Blair et al. teaches forming cobalt silicide while forming titanium nitride but does not teach without breaking the vacuum chamber and cleaning the substrate. However, Givens et al. teaches at col. 11, lines 1-14 and col. 10, lines 54-68, cobalt layer and titanium nitride layer are formed in situ without a vacuum break, and cleaning the insulating layer and substrate.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the above references' teachings without break the vacuum in the chamber between two metal deposition process because exposing to the air would form an interfacial metal oxide layer between the metal layers that would reduce the conductivity between metal layers, and cleaning the substrate would remove the contaminants that is formed on the substrate so that the adhesion between layers and leakage current in the device would be improved.

Claims 24-25 are rejected under 35 U.S.C 103 as being unpatentable over Sumi et al. as applied to claim 23 above, and further in view of Lee et al. 2001/0016413 and Tomita et al. 2003/0107133, newly cited.

The difference between the references applied above and the instant claim(s) is: Sumi teaches forming a unitary plug having cobalt silicide layer formed at the bottom of a contact hole but does not teach a TiN plug and thickness of the plug. However, Lee et al. teaches at para. 46-47, forming a titanium nitride plug 214 over a cobalt layer in the contact hole. And, Tomita teaches at para. 82 and 89, forming a contact hole 12 in the insulating layer 9 that has a thickness of 300 nm (3000 angstroms), then forming a TiN nitride plug in the contact hole.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the above references' teachings by forming a TiN plug in the contact hole as taught by Lee and Tomita because TiN plug is a refractory metal that has higher resistance to the etching chemicals in the subsequent processing steps and using a specific thickness of TiN plug so that optimum electric resistance can be obtained for device performance.

Conclusion

Applicant's arguments filed August 6, 2004 have been fully considered but they are not persuasive. Because newly cited reference, Blair teaches at col. 5, lines 50-67 and fig. 8, forming a cobalt silicide layer 36 at the bottom of the contact hole 28 while forming a CVD titanium nitride (TiN) layer 326 directly on the cobalt layer 324 and the metal silicide interface layer reaction conditions, such as temperature and gaseous ambient are selected and forming a unitary plug 324/326/338 as set forth above. And, Wiecaorek also teaches at col. 5, lines 32+ and fig. 2C and fig. 2D, forming a cobalt silicide layer 109 at the bottom of the contact hole 102 while forming a titanium nitride layer 115 directly on the cobalt layer 115, forming a unitary plug 117 on the titanium

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nitride layer 115 so as to fill the contact hole. And, Sumi also teaches at col. 4, lines 48+, forming a cobalt silicide layer (Co silicide) at the bottom of the contact hole while forming (filling the contact hole) a unitary plug on the cobalt layer.

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry of a general nature or clerical matters or relating to the status of this application or proceeding should be directed to the Group customer service whose telephone number is 571-272-1626.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to H. Jey Tsai whose telephone number is (571) 272-1684. The examiner can normally be reached on from 7:00 Am to 4:00 Pm., Monday thru Friday.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Niebling can be reached on (571) 272-1679. The fax phone number for this Group is (703) 872-9306.

hjt

10/21/04

A handwritten signature in black ink, appearing to read 'H. Jey Tsai', with a stylized, cursive-like script.

H. Jey Tsai
Primary Examiner
Patent Examining Group 2800